REMARKS

The specification has been amended in the paragraph beginning at page 7, line 28 to reference lines N in Fig. 4a, which depict directions normal to the surfaces of the amorphous ribbons comprised in tooth section 230 and back iron section 220. In addition, the paragraph of the specification beginning at page 10, line 14 has been amended to reference the rotational direction of rotor 100, which rotates about an axis centrally located in the rotor and perpendicular to the plan of Fig. 5.

Prints showing in red proposed amendments to drawing Figs. 4a and 5 have been submitted to the Official Draftsperson, for entry upon approval of the Examiner. As amended the prints (i) depict lines N normal to the surfaces of the amorphous metal ribbons of which the tooth section 230 and the back iron section 220 are comprised (Fig. 4a); and (ii) depict via line "R" the rotational direction of rotor 100.

In order to emphasize the patentable distinctions of applicants' invention over the prior art, claim 36 has been amended to recite (i) <u>that the segments of the claimed stator are heat-treated</u>; and (ii) <u>that said stator has a core loss less than "L" when operated at an excitation frequency "f" to a peak induction level B_{max} wherein L is given by the formula $L = 0.0074\, f\, (B_{max})^{1.3} + 0.000282\, f^{1.5}\, (B_{max})^{2.4}$, the core loss, said excitation frequency and said peak induction level being measured in watts per kilogram, hertz, and teslas</u>. The amendments to claim 36 bring out a salient feature of the invention by reciting a formula that defines the maximum core loss exhibited by the stator. Support for the amendment may be found, e.g. at page 15, lines 7-16, and page 18, lines 1-16. Each of the amendments to the specification, drawings and claims is clearly supported by the original specification.

In light of the above amendments, it is submitted that each feature of the invention called for by present claims 1 to 36 is clearly shown by the drawings, and that the objection to the drawings under 37 CFR §1.83(a) has been obviated.

Claims 1-36 have been rejected under 35 U.S.C. §112, first paragraph, as containing subject matter which is not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors had possession of the claimed invention at the time the application was filed. The Examiner has indicated that the specification does not have a full, clear, and concise written description of the stator with upper and lower surfaces having lines normal to the axis of rotation at any point in a segment with and without an air gap.

Applicants respectfully submit that the description appearing in the "Detailed Description of the Preferred Embodiments" section of the specification at page 6, lines 13-18, along with claims 1, 22, 26, 35, 36, 37, 41, and 47, and Figures 1-7, provides a full, clear, and concise written description of the invention that would enable one of ordinary skill to understand and practice the invention. Applicants have used the terms "surface," "normal," "axis of rotation," and "substantially any" in their ordinary manner in which geometrical objects are conventionally described. In particular, the top and bottom surfaces of a layer of amorphous metal are defined (e.g., at page 6, line 15, of the specification) by the length and width directions of an elongated, thin tape. In accordance with the usual definition in Euclidean geometry, a line normal to a surface at a point is a line perpendicular to any (equivalently, to each and every) line that passes through the point and that is contained within the surface. As defined by claim 1, the stator comprises a plurality of segments. Each of the segments comprises a plurality of layers of amorphous metal strips. Although these layers are stackingly arranged to form the segment, each retains an identifiable top and bottom surface. One having ordinary skill in the art would recognize that any point in either the top or bottom surface of each of the layers could be selected and a normal line constructed from that point. In addition, the skilled artisan would recognize that the electric motor in which the stator is adapted for use would

also have a rotor designed to rotate about an axis of rotation. It is then a straightforward geometrical procedure to determine whether the rotor's axis of rotation is substantially perpendicular to substantially any of the normal lines so constructed. For these reasons it is submitted that the description of the stator, whether with or without an air gap – as having layers such that a line normal to the upper or lower surfaces at any point thereon is perpendicular to the axis of rotation – is set forth in the specification with the degree of clarity and precision required by 35 U.S.C. §112, first paragraph.

Accordingly, reconsideration of rejection of claims 1-36 under 35 U.S.C. §112, first paragraph, is respectfully requested.

Claim 36 has been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to point out and distinctly claim the subject matter which applicants regard as the invention. The Examiner has indicated that claim 36 is vague and indefinite because it is unclear whether the line is normal to the upper and lower surfaces at any chosen point or at every chosen point on the stator.

Applicants respectfully submit that it is clear from the context of claim 36 and the specification that the term "any" is synonymous with "every". That is to say, the qualification of "any" by the adverb "substantially" both in claim 36 and at page 6, line 17, establishes that there is no significant limitation on the selection of points on the surface of the amorphous metal strips at which a normal line may be drawn. It is therefore submitted that the term "any" in claim 36 has been used in the conventional way, and is in accord with conventional dictionary parlance, one form of which is: "in affirmative sentences, often practically equivalent to every or all." (see New Webster's Dictionary Of The English Language, page 75, College Edition, Delair Publishing Company Inc., New York (1981). For the above reasons, it is submitted that claim 36, as amended, satisfies the standards of 35 USC §112, second paragraph, by pointing out and distinctly claiming the subject matter which applicants regard as their invention.

Accordingly, reconsideration of the rejection of claim 36 under 35 U.S.C. §112, second paragraph, as being vague and indefinite, is respectfully requested.

Claim 36 has been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,255,684 to Mischler et al.

Mischler et al disclose a stator structure for use in a motor which is fabricated using strip material and moldable magnetic composite, either amorphous metal tape and amorphous flake or similar conventional materials.

While Mischler et al. say that amorphous metal core material is promising for power applications because of its potential low magnetic losses, the patentees provide no teaching whatsoever concerning values of magnetic losses actually achieved by any stator structure they disclose or suggest. By way of contrast, applicants' amended claim 36 recites a brushless, radial-flux DC motor including a stator comprised of heat-treated segments of amorphous metal and having a core loss less than "L" when operated at an excitation frequency "f" to a peak induction level B_{max} wherein L is given by the formula $L = 0.0074 f (B_{max})^{1.3} + 0.000282 f^{1.5} (B_{max})^{2.4}$, the core loss, excitation frequency and peak induction level being measured in watts per kilogram, hertz, and teslas, respectively. Applicants respectfully submit that the advantageously low core loss of the stator required by amended claim 36 is neither disclosed nor suggested by Mischler et al.

Applicants further submit that significant bending stresses are imposed on the amorphous metal strip during construction of any of the stators suggested by Mischler et al. These stresses are most pronounced in regions having a very tight radius of curvature, such as at the corners of the structures depicted in each of the Mischler et al. Figures. These stresses cause significant degradation of the core loss of metal. By way of contrast, applicants teach, e.g. at page 11, lines 13-16, of the specification, the importance of minimizing stress by suitable heat treatment of the formed components of the stator structure. This teaching is specifically required by amended claim 36.

The importanbe of low stator core loss is set forth by applicants in the specification, e.g. at page 18, lines 1-23. The low value of core loss afforded by the present amorphous metal stator results in a motor that is more efficient, generates less waste heat that must be dissipated, and is capable of higher speed operation than a motor employing any conventional steel core material. The advantage of low core loss is especially important in motors in which either high pole count or high rotational speed dictates that the stator be excited by high frequency current.

In view of the amendment of claim 36 and the foregoing remarks, it is submitted that the brushless, radial flux DC motor defined by claim 36 is patentable over Mischler et al. Accordingly, reconsideration of the rejection of claim 36 under 35 U.S.C. § 102(b) is respectfully requested.

Claims 1, 2, 3, 8, 19-22, and 35 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over German Patent Document 28 05 438 (the "'438 patent") and U.S. Patent No. 4,255, 684 to Mischler et al.

The '438 patent discloses a motor comprising an iron core made of layers. The iron core consists of separate parts, which form joints having variable reluctance elements inserted therein. Strips of non-magnetic materials such as plastic foil hold the joints apart. Each of the joints opens out to form a large rectangular window near the inner face which may be used to hold coil windings. In operation, the flux must cross an air gap between the ends of a back and a tooth section. This disclosure does not teach that the metal used is an amorphous metal. Thus, the '438 patent teaches a conventional, crystalline metal stator wherein the flux must cross at least one (and most likely more than one) air gap.

The Examiner has indicated that each of the back iron sections in the '438 disclosure has a top and a bottom surface which has a line normal to the surface being perpendicular to the axis of rotation of the rotor. Applicants respectfully submit, however, that the pole shoe (3) in the figure of the '438 disclosure is depicted as being comprised of a stack of layers of steel. Each of these layers has a top and a bottom surface. As set forth in applicants' specification at page 3, lines 17-22, the

direction normal to these surfaces is generally parallel to the overall cylindrical axis of the stator structure depicted by the figure, which, in turn, is parallel to the axis of rotation of the rotor of a motor built with the '438 stator.

By way of contrast, the stator of present claim 1 is comprised of segments, each of which comprises a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. While the back iron portions (2) of the '438 stator satisfies the requirement of proviso (i), the pole shoe portions (3) do not. The difference in orientation between the pole shoe and the back iron segments in a stator constructed in accordance with the '438 disclosure adversely increases its magnetic reluctance and core loss, because the layers of the respective components join only at points of intersection, not substantially along line segments, as is the case with the structure defined by applicants' claims.

Mischler et al. disclose an amorphous metal stator typical of the prior art. In Mischler et al.'s stator, adjacent teeth (for example, as shown in Fig. 7 of Mischler et al., the tooth at 12 o'clock and the tooth at 3 o'clock) connected by a continuous backiron segment (shown at 38 in Mischler et al.'s Fig. 7) are magnetized simultaneously. In this manner, flux travels along a continuous segment (from the right side of the 12 o'clock tooth, through the backiron, to the top side of the 3 o'clock tooth), and does not have to jump across an air gap. This teaching of Mischler et al. points away from the stator called for by applicants' claims 1, 2, 3, 8, 19-22, and 35, wherein a plurality of teeth (for example, the tooth at 12 o/clock and the tooth at 6 o'clock) are magnetized simultaneously, and the flux must jump across the gap between the top and bottom sections of the 3 o'clock tooth.

Thus, applicants respectfully submit that even the combination of the '438 disclosure and Mischler et al. does not disclose or suggest the structure of the stator recited by claims 1, 2, 3, 8, 19-22, and 35, each of which requires a stator having a plurality of segments, each segment comprising

a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap.

The Mischler et al. limitation that the flux does not jump an air gap places severe restrictions on the performance of their motor. If a continuous segment of the Mischler et al. motor is magnetized (for example, the segment 38 in Mischler et al.'s Fig. 7), then only the right half of the 12 o'clock tooth and the top half of the 3 o'clock tooth are magnetized. The other halves of the 12 o'clock and 3 o'clock teeth represent parts of different, unmagnetized, segments. Effectively, only half of the volume of each tooth is magnetized. Therefore, if segment 38 is magnetized to 1.5 T, the 12 o'clock tooth will perform as if the entire tooth were magnetized to only 0.75T. This would provide <u>half the torque</u> of a tooth fully magnetized to 1.5T.

Clearly, the Mischler et al. limitation that the flux does not jump an air gap places restrictions on the combinations of frequency, speed and torque at which their motor operates. These restrictions, which have heretofore made amorphous metal stators unsuitable for conventional motor applications, have been eliminated by the stator called for by present claims 1, 2, 3, 8, 19-22, and 35. In contrast to the teaching the '438 patent, as modified by Mischler et al., the stator called for by applicants' claims 1, 2, 3, 8, 19-22, and has backiron and teeth constructed such that radial flux passing though the stator crosses just one air gap when traversing each segment of the stator. Overall versatility of the motor is improved; operational ranges and levels of speed, frequency and torque are increased. When compared with any stator constructed from the combined teachings of the '438 patent and Mischler et al., the stator recited by present claims 1, 2, 3, 8, 19-22, and 35 is smaller, lighter, much less expensive to construct and far more versatile and efficient in operation.

Applicants respectfully submit that it was not obvious to manufacture an amorphous metal rotor having the structure of the '438 patent. Had it been obvious to do so, Mischler et al. and other

prior art workers would have attempted to combine the teachings of the cited references and realized the significant advantages afforded by the stator delineated by applicants' claims. Clearly, up to the time of applicants' invention, no stator having the structure called for by claims 1, 2, 3, 8, 19-22, and 35 has been proposed by any prior art worker, including those represented on the '438 disclosure and Mischler et al. The prior art stators and their attendant disadvantages are discussed at pages 1 and 2 of the specification. It is submitted that the proposed combination of the '438 disclosure and Mischler et al. can be made only in light of applicants' own disclosure. Even then, any stator constructed from the combined teachings of the '438 disclosure modified in light of Mischler et al. would require substantial reconstruction and redesign which is not fairly taught by the references.

Assuming, arguendo that the '438 patent could be combined with Mischler et al., the resultant stator would still not possess a plurality of segments, each segment comprising a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of said surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of said rotor, and (ii) when traversing said segment, said flux crosses one air gap.

Rather, any stator constructed from the teachings of the cited references would be governed by Mischler's limitation that the flux does not jump an air gap. Restrictions placed on the combinations of frequency, speed and torque of such a stator by this limitation would render it unsuitable for many conventional motor applications. These restrictions have been eliminated by the amorphous metal stator called for by applicants' claims 1, 2, 3, 8, 19-22, and 35, which is smaller, lighter, less expensive to construct and more versatile and efficient in operation than any stator produced from the combined teachings of the cited references.

The Examiner has further indicated that heat treatment, application of a magnetic field, and annealing are methods of making limitations not germane to the patentability of the apparatus.

Applicants respectfully submit that heat treatment or annealing, whether or not a magnetic field is applied, structurally alters the stator recited in claims 19-21 and is thus properly germane to the determination of patentability of those claims. As set forth in the specification, e.g. at page 15, lines 7-16, heat treatment enhances the magnetic properties of the amorphous metal strip used in constructing the stator recited by claims 19-21. Moreover, the specification teaches that different forms of heat treatment result in different microstructures within the metal strip. The heat treatment recited at page 15, lines 10-11 modifies a substantially glassy or amorphous microstructure, whereas the heat treatment presented at page 15, lines 17-19 results in the formation of a nanocrystalline microstructure characterized by the presence of a high density of grains having average size less than about 100 nm. The specification teaches that each of these methods constitutes means for improving the magnetic properties of the amorphous metal strip, notably the core loss. A motor comprising a stator having low core loss operates with high efficiency and speed, low production of waste heat, and minimized need for auxiliary cooling means. The significance of low core loss is set forth in the specification, especially at page 16, line 30, through page 17, line 7, and is further discussed hereinbelow in conjunction with the rejection of claims 15-18 and 26-33 over the '438 patent and Mischler et al.

In view of the above remarks, applicants respectfully submit that the structural features of the stator are correctly characterized by claims 19-21 and provide proper basis defining patentably over the cited references. Further, it is submitted that the advantageous features afforded by the stator of present claims 1, 2, 3, 8, 19-22, and 35, including significant reductions in size and weight, lower construction costs and increased versatility and efficiency of operation, provide ample basis upon which to predicate their patentability over the art applied.

Accordingly, reconsideration of the rejection of claims 1, 2, 3, 8, 19-22, and 35 under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. is respectfully requested.

Claims 4, 5, and 23 have been rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 disclosure and Mischler et al. in further view of U.S. Patent No. 2,556,013 to Thomas, which discloses dynamoelectric motors having stator members provided with salient field poles. The stators have an outer cylindrical protective and retaining member, which is made of a non-magnetic material with good tensile strength qualities such as aluminum or stainless steel.

The Examiner has indicated that the '438 patent and Mischler et al. teach every aspect of the invention except a steel band peripherally around the stator. This indication is respectfully traversed.

As discussed hereinabove in connection with the 103(a) rejection of claims 1, 2, 3, 8,19-22, and 35 over the '438 patent and Mischler et al., present claim 1 calls for a stator comprised of segments, each of which comprises a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Even taking the '438 patent and Mischler et al. teaching together, there is not produced any suggestion whatsoever concerning a stator that satisfies the combined requirements of provisos (i) and (ii).

The Examiner has indicated that it would be obvious to construct a stator of the type defined by the '438 patent and Mischler et al. with the steel band disclosed in Thomas. Like Mischler et al., Thomas does not disclose or suggest an amorphous metal stator wherein the flux crosses only one air gap. Thomas also teaches a stator composed of stacked laminations, each having a surface whose normal is parallel, not perpendicular, to the axis of rotation of the rotor with which the stator is associated. Further, Thomas does not teach an amorphous metal stator that is not brittle, and which exhibits increased magnetic permeability and overall efficiency without adverse thermal characteristics. In this respect, Thomas does not add to the teaching of the '438 patent and Mischler et al. and cannot be combined therewith to render obvious the invention recited by claims

4, 5, and 23. When compared to any stator constructed in view of the teaching of the '438 patent, modified in light of Mischler et al. and further modified in light of Thomas, the stator required by present claims 1, 2, 3, 8, 19-22, and 35 exhibits increased economy of construction and improved operating versatility and efficiency.

Accordingly, reconsideration of the rejection of claims 4, 5, and 23 as being unpatentable over the '438 patent, Mischler et al. and Thomas is respectfully requested.

Claims 6, 7, 24, and 25 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the '438 patent, Mischler et al., Thomas, and further in view of U.S. Patent No. 3,591,819 to Laing.

The Examiner has indicated that the '438 patent, Mischler et al., and Thomas teach every aspect of the invention except the bonding material being an epoxy resin and the inner restraining member being a bonding material and a metal band. For the reasons set forth above in conjunction with the rejection of claims 4, 5, and 23 under 35 U.S.C. § 103(a) over the '438 patent, Mischler et al., and Thomas, applicants respectfully traverse this statement. It is submitted that Thomas does not cure the lack of disclosure in the '438 patent and Mischler et al. concerning a stator comprising amorphous metal strips oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap.

The Examiner has indicated that it would be obvious to construct the stator of the '438 patent, Mischler et al. and Thomas with the synthetic resin taught by Laing. Applicants submit that even if the combination proposed by the Examiner were made, such a stator would lack the advantageous structure and properties exhibited by the stator defined by claims 6, 7, 24, and 25.

Like Mischler et al. and Thomas, Laing does not disclose or suggest amorphous metal stators wherein the flux crosses only one air gap. Like Thomas, Laing also teaches a stator composed of stacked laminations, each having a surface whose normal is parallel, not perpendicular, to the axis of rotation of the rotor with which the stator is associated. Further, Laing does not teach an

amorphous metal stator which is not brittle, and which exhibits enhanced magnetic permeability and overall efficiency without adverse thermal characteristics. In this respect, Laing does not add to the teachings of the '438 patent, Mischler et al. and Thomas, and cannot be combined therewith to render obvious the invention recited by present claims 6, 7, 24, and 25. Any stator constructed from the combined teachings of the '438 patent, Mischler et al., Thomas and Laing would lack the structure and advantageous properties of the stator delineated by present claims 6, 7, 24, and 25, and as such would be far more expensive to construct and operate.

Accordingly, reconsideration of the rejection of claims 6, 7, 24, and 25 as being unpatentable over the '438 patent, Mischler et al., Thomas and Laing is respectfully requested.

Claims 9 and 34 have been rejected as being unpatentable over the '438 patent and Mischler et al. in view of U.S. Patent No. 4,197,146 to Frischmann. The Examiner has indicated that it would have been obvious to construct the stator of the '438 patent and Mischler et al. with the amorphous metal composition disclosed in Frischmann.

Like Mischler et al., Frischmann does not disclose or suggest an amorphous metal stator wherein the flux crosses only a minimum number of air gaps. In addition, the stator disclosed by Frishmann requires that the flux cross many air gaps, that is, the gaps between the compacted, discontinuous flakes. As a result, the Freshmann stator is inherently incapable of exhibiting enhanced magnetic permeability and overall efficiency without adverse thermal characteristics. While Frischmann discloses an amorphous metal composition for fabricating electrical magnetic components, his stator lacks the advantageous features afforded by the stator called for by applicants' claims 9 and 34. Moreover, Frischmann does not remedy the lack of disclosure in the '438 patent and Mischler et al. concerning the particular orientation of amorphous metal strips called for by claims 9 and 34. In these respects, Frischmann does not add to the teaching of the '438 patent and Mischler et al., and cannot be combined therewith to render obvious the invention recited by claims 9 and 34.

Accordingly, reconsideration of the rejection of claims 9 and 34 under 35 U.S.C. §103(a) over the '438 patent, Mischler et al. and Frischmann is respectfully requested.

Claims 10 and 11 have been rejected as being unpatentable over '438, Mischler et al., and Frischmann in further view of U.S. Patent No. 4,409,041 to Datta et al. The Examiner has indicated that '438, Mischler et al., and Frischmann teach every aspect of the invention except the FeBSi formula and that it would have been obvious to construct the stator of '438, Mischler et al., and Frischmann with the amorphous metal set forth in claims 10 and 11, because Datta et al. suggest the disclosed compositional range, as well as the disclosed range for enhancing the composition's magnetic properties.

The Examiner's indication that the '438 patent, Mischler et al., and Frischmann teach every aspect of the invention except the FeBSi formula is respectfully traversed, for the reasons set forth above in connection with the remarks on the rejection of claims 10 and 11 under 35 U.S.C. §103(a).

The Datta et al. disclosure is directed to an iron-based, boron containing magnetic alloy having at least 85 percent of its structure in the form of an amorphous metal matrix annealed in the absence of a magnetic field at a temperature and for a time sufficient to induce precipitation therein of discrete particles of its constituents. No disclosure or suggestion is provided by Datta et al. of the desirability of using amorphous metal in the construction of electric motor components. Moreover, the disclosure of magnetic properties found in Datta et al. is directed to high frequency properties. Each of the examples in Datta et al. discloses properties measured on a magnetic core having a closed magnetic path and carried out e.g. at a frequency of 50 kHz and at an induction level of 0.1 T. One skilled in the art would recognize that losses measured in an open magnetic circuit are higher than those seen in a closed path, as discussed in more detail by applicants in the specification at page 17, lines 20-31.

Clearly the Datta et al. disclosure is directed to core applications, not to motors or other rotating devices. Applicants thus submit that one of ordinary skill would not be motivated to

combine the Datta et al. disclosure with any of the '438 patent, Mischler et al., and Frischmann. However, even assuming arguendo that the combination of the '438 patent, Mischler et al., and Frischmann with Datta et al. were to be made, the resulting stator would still lack the advantageous structure and properties afforded by applicants' stator, as recited by claims 10 and 11. More specifically, the stator would not have in combination a structure having a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. As a consequence, any stator constructed from the combined teachings of the cited references would lack the advantageous magnetic properties, including high induction and low material cost (see page 14, line 29, to page 15, line 5 of applicants' specification) afforded by the stator of present claims 10 and 11. For these reasons, applicants respectfully submit that the stator recited by claims 10 and 11 is patentable over any combination of the '438 patent, Mischler et al., Frischmann, and Datta et al.

Accordingly, reconsideration of the rejection of claims 10 and 11 under 35 U.S.C. §103(a) is respectfully requested.

Claim 12 has been rejected under 35 U.S.C. §103(a) as being unpatentable over of the '438 patent, Mischler et al., and Frischmann, in further view of U.S. Patent No. 5,922,143 to Vernin et al. The Examiner has indicated that the '438 patent, Mischler et al., and Frischmann, teach every aspect of the invention except nanocrystalline microstructure.

The Vernin et al. patent discloses a process for manufacturing a magnetic core made of an iron-based soft magnetic alloy having a nanocrystalline structure. The alloy is formed into a toroidal magnetic core and heat-treated based on particular conditions determined on the basis of the use envisaged for the magnetic core. No suggestion or disclosure is provided in the Vernin et al patent of application of nanocrystalline alloys in motors or other rotating electrical machinery. As discussed hereinabove in connection with the rejection of claims 10 and 11 over the '438 patent,

Mischler et al., and Frischmann, in further view of U.S. Patent No. 4,409,041 to Datta et al., applicants submit that one of ordinary skill would not be motivated to combine the Vernin et al. disclosure, which is directed to magnetic core applications, with any of the '438 patent, Mischler et al., and Frischmann, each of which discloses aspects of electric motor construction.

However, even the Examiner's proposed combination of Vernin et al. with the '438 patent, Mischler et al., and Frischmann were to be combined with Vernin et al. in the manner proposed by the Examiner, the resultant device would still not suggest the stator called for by applicants' claim 12. As discussed hereinabove, applicants' claims call for a stator comprised of segments, each of which comprises a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. None of the cited references or any combination thereof suggests this combination of structural features. In contrast, the presence of these features in applicants' stator as recited by claim 12 results in low core loss and thus a motor that is smaller, lighter, less expensive to construct and more versatile and efficient in operation than a motor employing a prior art stator.

As previously discussed, the low value of core loss afforded by the present stator results in a motor that is more efficient, generates less waste heat that must be dissipated, and is capable of higher speed operation than a motor employing any conventional steel core material. As discussed in detail by the specification, e.g. at page 16, lines 18-19 and 27-29, stators employing nanocrystalline alloy strip are especially preferred for motors wherein minimum size and high speed operation are desired.

It is therefore submitted that the proposed combination of Vernin et al. with the '438 patent, Mischler et al., and Frischmann, even if proper, does not disclose or suggest the stator recited by present claim 12.

Accordingly, reconsideration of the rejection of claim 12 under 35 U.S.C. §103(a) as being unpatentable over the combination of the '438 patent, Mischler et al., Frischmann, and Vernin et al., is respectfully requested.

Claims 13 and 14 have been rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent, Mischler et al., Frischmann, and Vernin et al., in further view of U.S. Patent 4,881,989 to Yoshizawa et al. The Examiner has indicated that the '438 patent, Mischler et al., Frischmann, and Vernin et al. teach every aspect of the invention except the compositions set forth in claims 13 and 14 and that it would be obvious to construct the stator of the '438 patent, Mischler et al., Frischmann, and Vernin et al. with the compositions of claims 13 and 14.

Yoshizawa et al. discloses an iron-base soft magnetic alloy having a composition represented by the general formula: $(Fe_{1-a}M_a)_{100-x-y-z-\alpha-\beta-\gamma}Cu_xSi_yB_zM'_\alpha M''_\beta X_\gamma$ wherein M is Co and/or Ni, M' is at least one element selected from the group consisting of Nb, W, Ta, Zr, Hf, Ti and Mo, M" is at least one element selected from the group consisting of V, Cr, Mn, Al, elements in the platinum group, Sc, Y, rare earth elements, Au, Zn, Sn and Re, X is at least one element selected from the group consisting of C, Ge, P, Ga, Sb, In, Be and As, and a, x, y, z, α, β, and γ, respectively, satisfy $0 \leq a \leq 0.5$, $0.1 \leq x \leq 3$, $0 \leq y \leq 30$, $0 \leq z \leq 25$, $5 \leq y+z \leq 30$, $0.1 \leq \alpha \leq 30$, $\beta \leq 10$ and $\gamma \leq 10$, at least 50% of the alloy structure being fine crystalline particles having an average particle size of 100 nm or less. This alloy is said to have low core loss, time variation of core loss, high permeability and low magnetostriction. Yoshizara et al. also discloses toroidal magnetic cores for use in various transformers, choke coils, saturable reactors, magnetic heads, and the like.

Applicants respectfully traverse the position of the Examiner that the '438 patent, Mischler et al., Frischmann, and Vernin et al. teach every aspect of the invention except the compositions set forth in claims 13 and 14. As set forth above in connection with the discussion concerning the rejection of claim 12 under 35 U.S.C. §103(a), applicants submit that the combination of the '438 patent, Mischler et al., Frischmann, and Vernin et al. does not suggest a stator having a plurality of

segments, each segment comprising a plurality of layers of amorphous metal strips; each of which layers has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap, required by present claims 13 and 14.

Moreover, the Yoshizawa et al. disclosure does not have any teaching concerning the utility of any composition therein for the construction of electric motors or other rotating electrical machines. As is well recognized in the motor art, the disparate properties needed for construction of rotating machines and for electronic cores lead to entirely different classes of magnetic alloys being preferred for these respective applications. Applicants thus submit that a skilled artisan would not be motivated to combine the Yoshizawa et al. disclosure directed to electronic core applications with the Mischler et al and '438 disclosures as proposed by the Examiner.

However, even assuming that the combination of Yoshizawa et al. with '438, Mischler et al., Frischmann, and Vernin et al. could properly be made, it would not render obvious the stator called for by applicants' claims 13 and 14. For any stator produced in light of the combined teachings of the cited references would still lack the advantageous structure and properties afforded by applicants' stator, as recited by claims 13 and 14. More specifically, any stator constructed from the combined teachings of the cited references would not contain in combination a structure having a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Moreover, such a stator produced from the combined teachings of the cited references would clearly lack the advantageous magnetic properties afforded by the stator of applicants' claims 13 and 14. As set forth at page 16, lines 18-19 and 27-29 of applicants'

specification, stators employing nanocrystalline alloy strip are especially preferred for motors wherein minimum size and high-speed operation are desired.

Accordingly, reconsideration of the rejection of claims 13 and 14 under 35 U.S.C. §103(a) over the combination of the '438 patent, Mischler et al., Frischmann, and Vernin et al., with Yoshizawa et al. is respectfully requested.

Claims 15-18 and 26-33 have been rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. The Examiner has indicated that the '438 patent and Mischler et al. teach every aspect of the invention except the core loss and frequency range of the magnetic material, and it would be obvious to the skilled artisan to construct the stator core of the '438 patent and Mischler et al. with the core loss defined by the formula of claim 15.

Applicants respectfully traverse this statement. As discussed hereinabove in connection with the rejection of claims 1, 2, 3, 8, 19-22, and 35 over the combination of the '438 patent and Mischler et al., each of claims 15-18 and 26-33 recites a stator having a plurality of segments. Each segment comprises a plurality of layers of amorphous metal strips, and each of layer of strip has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Clearly, this combination of structural elements is not disclosed or suggested by the combination of the '438 patent and Mischler et al. In fact, as previously noted, the proposed combination of '438 patent and Mischler et al. teaches away from the stator structure that contains the elements of provisos (i) and (ii).

Moreover, applicants respectfully disagree that it would be obvious to obtain the core loss e.g. as provided by the formula in claim 15 or the particular values set forth e.g. in claims 16-18.

It is well recognized in the art that core loss and permeability are <u>extrinsic</u> properties of soft magnetic materials. An extrinsic property is one that is not uniquely specified or predictable with a degree of certainty solely as a consequence of a composition of matter. Such properties are known

to vary, possibly to a significant degree, as a result of factors such as the processing history of the material, its environment, and its geometric disposition, *inter alia*. Typical extrinsic properties of metals include mechanical strength. In contrast, intrinsic properties are substantially unaffected by processing and other external factors. Intrinsic properties include mass density and electrical conductivity.

Over the years, prior art workers in the soft magnetic materials art have devoted extensive efforts to develop materials and associated processing methods that allow desirable extrinsic properties to be realized in a desired magnetic structure. Notable among those desirable extrinsic properties so fervently sought is low core loss. The present invention is directed to an electric motor comprising a bulk magnetic component that has the outstanding combination of high mechanical strength and low core loss. Notwithstanding the significant expenditure of capital and energy during development efforts consuming more than thirty years, these requirements – high mechanical strength and low core loss -- have heretofore been considered to be mutually contradictory.

Moreover, it is well recognized in the art of soft magnetic materials that excessive core losses can arise from a wide variety of factors. Highly magnetostrictive materials, including many amorphous metal compositions, are known to be highly vulnerable to externally or internally imposed stresses. In the presence of stress, contributions to core loss from both the hysteresis and eddy current mechanisms increase dramatically. Insulation of adjacent layers or particles has no effect on these contributions, which arise solely within each layer or particle.

While Mischler et al. recognizes in very general terms the desirability of obtaining low losses and that amorphous metal is promising as a low core loss material for power applications (see e.g. column 1, lines 13-16), no method, general or specific, is disclosed by Mischler et al. to accomplish that objective in the extremely demanding context of electric motor components. More specifically, there is no disclosure or suggestion of the need for processing that mitigates the problems that are known to occur as the result of stresses imposed during manufacture. The severity

of these problems in the construction of motor components is recognized, e.g., at column 1, line 55 through column 2, line 25 of U.S. Patent 5,731,649 to Caamano, which is of record in the present case. Accordingly, applicants respectfully submit that the achievement of the low core loss values recited by claims 15-18 and 26-33 is not merely a matter of design choice. Rather, it represents an unexpected consequence of the advantageous combination of structure and choice of amorphous material delineated by present claims 15-18 and 26-33. It is therefore submitted that claims 15-18 and 26-33 are patentable over the combination of the '438 patent and Mischler et al.

Accordingly, reconsideration of the rejection of claims 15-18 and 26-33 under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. is respectfully requested.

Claims 19-21 and 28-30 have been rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. in further view of U.S. Patent No. 4,763,030 to Clark et al.

The Clark et al. patent discloses a metallic glass ribbon having the formula $Fe_wB_xSi_yC_z$ wherein $0.78 \leq w \leq 0.83$, $0.13 \leq x \leq 0.17$, $0.03 \leq y \leq 0.07$, $0.005 \leq z \leq 0.03$, and $w+x+y+z=1$. The ribbon is annealed to remove mechanical strains and exposed to a magnetic field in the plane of the ribbon and transverse to the long axis of the ribbon. The resulting metallic glass ribbons have very large magnetic coupling coefficients ($k_{33} > 0.9$). The treated ribbons are said to be useful in magnetostrictive transducers and in passive listening devices such as hydrophones or pressure sensors. No disclosure is provided by the Clark et al patent of the use of metallic glass or amorphous metal ribbon in the construction of components of electric motors. Moreover there is no suggestion in Clark et al. that amorphous metal ribbons having high magnetomechanical coupling factor are advantageous for use in construction of an electric motor.

The Examiner has stated that the '438 patent and Mischler et al. teach every aspect of the invention, except the heat treatment, application of a magnetic field, and annealing the segments. This statement is respectfully traversed. As discussed hereinabove in connection with the 103(a) rejection of claims 1, 2, 3, 8,19-22, and 35 over the '438 patent and Mischler, present claim 1 calls

for a stator comprised of segments. Each of the segments comprises a plurality of layers of amorphous metal strips, and each of the strips has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Even taking together the '438 patent and Mischler et al. teachings, there is no suggestion therein concerning a stator that satisfies the combined features of provisos (i) and (ii). Clark et al. do not disclose or suggest use of amorphous metal in electric motor components of any kind, let alone construction of the amorphous metal stator set forth in present claims 1, 2, 3, 8,19-22, and 35. Clearly, a stator constructed in accordance with the combined teaching of the '438 patent and Mischler et al, even if annealed in the manner taught by Clark et al., would still lack the advantageous combination of structure and properties afforded by applicants' stator, as recited by claims 19-21 and 28-30. The stator would not comprise amorphous metal strips oriented such that, when traversing a segment, the flux crosses one air gap, as required by present claims 19-21 and 28-30 wherein the flux crosses only one air gap. It would not comprise amorphous metal strips oriented such that a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor. Thus, the Clark et al. teaching does not add to the teachings of the '438 patent and Mischler et al. and cannot be combined therewith to render obvious the invention recited by present claims 19-21 and 28-30.

The Examiner further indicates that claims 28-30 are method of making limitations which are not germane to the patentability of the apparatus. As discussed hereinabove in conjunction with the rejection of claims 1, 2, 3, 8, 19-22, and 35 under 35 U.S.C. § 103(a), applicants respectfully submit that heat treatment or annealing, whether or not a magnetic field is applied, is a structural feature of the stator recited in claims 28-30 also and is thus properly germane to the determination of patentability of those claims.

Accordingly, reconsideration of the rejection of claims 19-21 and 28-30 under 35 U.S.C. §103(a) over the '438 patent, Mischler et al. and Clark et al. is respectfully requested.

In view of the amendments to the drawings, specification and claim 36, and the remarks set forth above, it is submitted that the present application is in allowable condition. Reconsideration of the rejection of claims 1-36 and allowance of the application are, therefore, earnestly solicited.

Respectfully submitted,
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By ______________

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